

The difference in the constant b which exists between poikilothermic and homoiothermic organisms seems to indicate that the protoplasmic viscosity is regulated with regard to the thermal adaptation of a given species.

Any biological reaction is a complex of many physical and chemical processes forming a chain. In determining the temperature coefficient of such a complex, we in effect determine the temperature coefficient of only one of the underlying processes, namely, that which is least accelerated by rising temperature and is therefore the limiting factor of the whole complex (Blackmann's and Pütter's principle). In the majority of cases, however, the rate of molecular diffusion in the protoplasm is the limiting factor (see W. M. Bayliss²⁵). As the rate of diffusion depends on the viscosity of the reacting system, our hypothesis is justified also from a purely physico-chemical point of view.

Thus the protoplasmic viscosity may be studied by simply measuring the effect of temperature on any biological reaction in which the new formula holds good. Further investigations will show whether this way of determining the protoplasmic viscosity would be not only less injurious to the living system, but also more accurate than the existing methods of protoplasmic viscosimetry (see F. Weber²⁶).

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Science and Psychical Research.

HAVING read with interest the correspondence in recent issues of NATURE arising out of Dr. Tillyard's article on Sir A. Conan Doyle's "History of Spiritualism," I beg space for the following remarks which I shall try to confine so far as possible within the editorial limits stated in the issue of September 11 to be the main point of the reviewer's article of July 31, namely, "that scientific men generally presented an unscientific attitude to the subject of psychical research." But Dr. Tillyard in his article appears to prefer the substitution of the term 'supernormal phenomena' to the term 'subject of psychical research.' Therefore my remarks will deal almost wholly with that department of 'psychical research' which concerns itself with such supernormal phenomena as may be included under the head of *accounts given of communications between living persons and the 'discarnate' spirits, or 'intelligencies,' or 'ghosts' of those who are normally called the dead,* and thus omit here all reference to much of the material studied by the Psychical Research Society, for example, telepathy, etc., as quite irrelevant to this correspondence.

All the statements regarding the above-named accounts hitherto published and believed to be true by some of all descriptions of persons, including such as are or have been students of various branches of science, lack any evidence of a character which could make possible their submission to strict scientific investigation, the requirements of which I need not repeat in these pages. In this statement I include all the accounts given or referred to by Sir A. C. Doyle or his reviewer in the "History of Spiritualism." Recently when talking with Sir Ray Lankester about a review he had written of Sir A. C. Doyle's book, and the ghost-stories it contained, he brought to my notice the following quotation from some remarks made by Mr. T. P. O'Connor in the *Sunday Times* of August 15

in connexion with a conversation with Sir Edward Clarke, the chief counsel for the plaintiff in the case of O'Shea v. Parnell. In the course of this case it was proved that there was no 'fire-escape' in the house in question. "This," says Mr. O'Connor, "was not the first time I realized the truth of the statement that you cannot be quite sure that you know all the facts of any historical or personal transaction. I never trust implicitly any historical statement. I have rarely seen any of the historical transactions in which I myself have taken a part strictly recorded according to the facts." Sir Ray thoroughly endorsed Mr. O'Connor's attitude as to placing no reliance on such 'story-telling,' and holds that it applies, equally to reputed researches by eminent scientists—all hearsay—and useless as evidence.

On all of the many occasions, within a period of more than fifty years, when I have given serious attention to allegations of facts made by students of the 'occult' or so-called 'supernormal phenomena,' I have found that the actual necessities for carrying out scientific investigation were unattainable, the consent of the 'medium,' whether 'professional' or not, being withheld.

Scientific men generally do not refuse to examine into any matters of reputed or seeming importance on the ground of certain alleged facts being impossible, or even highly improbable. They cannot, however, but refuse to make inquiry into any matter when the conditions of investigation, necessarily required, are denied or restricted and actual experiment thus excluded. As one example only of an unproved statement made in the course of the present correspondence, I quote that of Dr. Tillyard's in which he says that in a certain class of cases "the medium is actually in trance and does not know what is going on." I do not know what he means by the word 'trance,' but his statement would seem to be of some importance to spiritualists and the Psychical Research Society, as in the present dispensation of their doctrines the 'entranced' medium plays a most important part in the manifestations of occult phenomena generally. I am not aware, after making several inquiries into this point, of any thorough investigation having been made into the condition of a 'medium' reported to be 'entranced.'

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September 17.

THE present controversy, which the editor of NATURE has wisely confined to a discussion of the "scientific study of what are called *supernormal phenomena*," is somewhat confused by the irrelevancies which have been introduced into the debate.

The entomologist, Dr. Tillyard, complains that his critics confuse psychical research with spiritualism, when the fact is that his original article was a review of a book on spiritualism and not on psychical research. Moreover, when he accuses Dr. Lotsy of making "the usual blunder of those who, knowing nothing of the elementary principles of psychical research, persist in regarding the medium as the 'guide' in the experiments," he himself is betraying his lack of acquaintance with the subject. This is readily excusable since, I believe, his experience with physical mediums is limited to less than a dozen sittings. Apart from this, Dr. Tillyard's statement strikes at the root of the present discussion. The majority of scientific men suspect that what Dr. Tillyard denies is true, namely, that the medium is the 'guide' in the experiments. In this they are right, although the words 'and his/her manager' might be added to the word 'medium.'

The conditions of experiment are usually arranged

²⁵ Bayliss, "Principles of General Physiology," London, 1918, p. 41 seq.

²⁶ F. Weber, *Abderhalden's Handb. d. biol. Arbeitsmeth.*, vol. 11, 2, 1, half, 1924.

by the medium or by the manager in conformity with a set of arbitrary rules laid down by generations of spiritualists for reasons into which we need not enter here. The séances are of the nature of performances at which the 'investigator' takes his place in a 'chain' of believers, who see that he does not violate the rules, which are framed in such a way that any real investigation is impeded. Can Dr. Tillyard tell us of any single medium who can produce some simple raps, under conditions which render their normal production impossible? He will doubtless reply by stating that 'supernormal' phenomena are subject to certain conditions and it is only under certain conditions that they occur. This appears reasonable, but Dr. Tillyard's experience is too slight for him to be able to recognise that the conditions are not "just exactly what the researchers choose to make them" (*NATURE*, September 11, 1926, p. 370), but what the medium plus his manager or employer have chosen to make them.

In this respect the cordial invitations which are so often extended to prominent persons are highly suggestive. It is now becoming a common thing when a new medium appears for his or her manager to invite scientific men in other spheres of work, journalists, actors, etc., to be present at the 'experiments.' Great care is taken to prevent the systematic attendance of critical psychical researchers and others with much experience of mediums, for these are not likely to be impressed by the trappings of a pseudo-investigation, and are also acquainted with those sources of error which, from their very nature, must remain unknown to the ordinary scientific worker, who has not specialised in this line of inquiry.

There is a good case for the scientific study of what are called supernormal phenomena. The difficulty lies in obtaining the opportunities for any such investigation under conditions satisfactory to those whose experience leads them to adopt a critical attitude towards the problems in dispute.

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The Egyptian Shadouf and the Rate of Human Work.

THE interesting paper by Drs. Haldane and Henderson in *NATURE* for August 28, p. 308, merits emphasis on two or three points. Above all, the mechanical beauty of the shadouf, in spite of its crude construction, deserves notice. It will be observed that trunnion bearings, which would wear and need lubrication, are replaced by almost frictionless hinges in the form of ropes. These ropes, in addition to their antifriction qualities as hinges, confer an important property on the system, namely, elasticity.

In short, the shadouf is a pendulum, and almost without doubt the men who work it move with it in its natural free period. If this is so, it would constitute a remarkable anticipation of recent developments in Germany, where many reciprocating machines have been constructed on resonance principles with marked gain in efficiency.

About the middle of last century, when most cranes and winches were operated by hand, it was necessary, for purposes of design, to have some standard of human activity. A widely accepted figure for such work was one-tenth of a horse-power or 3300 foot-pounds per minute. D. K. Clerk, a respected authority of that period, gave this rate as "the

average net daily work of an ordinary labourer at a pump, a winch or a crane, for eight hours a day." "For shorter periods, from four to five times this rate may be exerted." Taking the rate given by Clerk for eight hours, we have 1,584,000 foot-pounds per day, in close agreement with the shadouf worker's 1,550,000 foot-pounds.

As to extreme rates of activity for short periods, comparisons are most difficult. Probably the highest rates are exhibited by professional wrestlers and strong men, whose feats are sometimes performed at a rate of the order of four horse-powers.

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THE figures of 4290 foot-pounds per min. for raising water, and 4230 foot-pounds per min. for raising earth, given by Dr. Haldane and Prof. Yandell Henderson in *NATURE* of August 28, as examples of the rate at which work can be kept up for lengthy periods, are confirmed by the common experience of hill climbers. A man of average weight, dressed in climbing kit, and carrying a load of, say, 15 or 20 lb., may be assumed to weigh about 180 lb. To walk uphill at the rate of 1250 feet per hour, at low or moderate altitudes, is quite ordinary; while 1500 feet per hour is generally considered as distinctly fast. Such figures would apply to persons in good training, and to ascents lasting for, say, 4 hours. The rate to correspond with 4200 foot-pounds per min. would be 1400 feet per hour.

It would be interesting to measure the rate of oxygen consumption of persons walking uphill for lengthy periods; for given rates of ascent and for various gradients; and to compare the results with figures obtained from the same individuals working an ergometer in a laboratory. The question of gradient cannot be entirely ignored. Clinometer measurements of Alpine paths indicate that the economic gradient is about 18°, or 1 in 3. It certainly lies between 16°, which is unnecessarily flat, and 20°, which is uncomfortably steep.

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Antagonistic Action of Electrolytes and Permeability of Membranes.

THE problem of the antagonistic action of electrolytes in biological systems has attracted attention for a long time, but a similar effect on inorganic colloidal systems has been investigated only in recent years. This study has, however, thrown considerable light on the mechanism of such antagonistic action, and we are now probably able to give a rational explanation on the basis of these physico-chemical investigations. About a decade ago Clowes (*Jour. Phys. Chem.*, 20, 407, 1916) showed that a marked analogy exists between the transformation of an emulsion of oil-in-water into an emulsion of water-in-oil, or of blood plasma into a blood clot, or of a casein suspension into a casein clot. In all these cases salts of calcium promote and alkalis and salts of sodium inhibit the transformation of a system consisting of a non-aqueous phase dispersed in water into the reverse type of system, consisting of water more or less perfectly dispersed in a non-aqueous phase, and the ratio in which given electrolytes, say